STAT [redacted]

ELECTROPHOTOGRAPHIC PROCESSING TECHNIQUES

STAT CONTRACT NO. [redacted], TASK ORDER NO. 03(100,762)65-R

Monthly Narrative Report - January 1966

This is the seventh of a series of monthly narrative reports on a study of electrophotographic processing techniques. The study comprises the investigation and development of electrical-chemical and electronic techniques for processing photographic images so as to improve their perceptibility to human observers. This report covers the work performed by the [redacted] STAT

STAT [redacted] during the period from 22 December 1965 to 22 January 1966.

The key to the electrical-chemical processing is control of acutance and granularity in processed transparencies by adjustment of density thresholds, expansion and contraction of densities and application of modulated-light contact printing. The key to the electronic processing, both analogous and complementary to the electrical-chemical processing, is separate and simultaneous operation on the high and low frequency information in the photographic images.

A. Current Status of Work

1. Electrical-Chemical Processing

Preparation of the degraded test targets for initial processing experiments was completed. Each transparency is a composite image containing an array of density-segmented triangles and a scene, both subjected to a known degree of defocus, over-exposure or smear. Corrective replication of the defocussed samples has begun using masking, composites requiring precise registration, and diffraction systems. The initial processing experiments cited above employ photo-masking (manual dodging) techniques which are complicated and time-consuming. Upon its availability, the automatic dodging and modulated-light printer will be incorporated into the corrective replication cycle.

The debugging of the breadboard modulated-light contact printer continued during the monthly period. Several electrical and optical modifications were made to improve the performance of the equipment. Completion of this task is anticipated for early in the next monthly period.

2. Electronic Processing

Final experiments were performed with the low-resolution breadboard electronic processing system. Scene images and test samples (i.e., the composite images prepared in the photographic laboratory) were processed to record the performance of the equipment prior to its disassembly. When this task was completed,

construction of the high-resolution breadboard system was begun.

A full analysis and evaluation of the experimental results will be performed during the next monthly period. Initial indications are that image perceptibility was improved by electronic processing. However, sharpened edges exhibited overshoots which must be studied. Also, the masking resolution appeared to be lower than estimated from the original mathematical model of the system.

Further theoretical analysis of modulated-light techniques, centered about a mathematical model of modulated-light contact reproduction (printing and viewing) systems, was therefore begun. The analysis is being made in terms of the line spread functions and spatial frequency responses of the system elements (e.g., original transparency, kinescope beam spots, and electronic feedback circuits). Under this task, experimental and analytical results will be correlated.

B. Problem Areas Encountered

No new major problem areas were encountered during the monthly period.

C. Projected Work for Next Monthly Period

1. Electrical-Chemical Processing

a. Complete corrective replication of degraded test targets.*

b. Analyze and evaluate processed images (a) with respect to degraded and original samples.*

c. Determine performance characteristics of modulated-light contact printer, and calibrate equipment.

d. Perform corrective replication of degraded test targets with modulated-light contact printer.**

e. Select and evaluate typical scene images for processing.

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*Discussions with the customer subsequent to the end of this reporting period indicated that the corrective replication of the degraded targets using the time consuming photocopy techniques alone should be curtailed. Hence, this processing is being stopped midway through the next month and the analysis and evaluation performed only for the limited processing.

**During the same discussions (as in *), the customer indicated that the further processing experiments should concentrate on the scenes (1.e) rather than the targets. This is the current plan.

2. Electronic Processing

a. Begin construction of high-resolution breadboard processing system.

b. Analyze and evaluate results of final processing experiments with low-resolution breadboard system.

c. Continue theoretical analysis of modulated-light contact reproduction (printing and viewing) systems.

d. Correlate experimental and analytical results.

D. Status of Fund Expenditures to End of Monthly Period

Funds expended (and committed) at break-even level to 30 January 1966:

STAT

E. Documentation of Verbal Commitments and/or Agreements During the Period

No special verbal commitments or agreements were made during the period.

ELECTROPHOTOGRAPHIC PROCESSING TECHNIQUES

STAT CONTRACT NO. [redacted] TASK ORDER NO. 03(100,762)65-R

Monthly Narrative Report - December 1965

This is the sixth of a series of monthly narrative reports on a study of electrophotographic processing techniques. The study comprises the investigation and development of electrical-chemical and electronic techniques for processing photographic images so as to improve their perceptibility to human observers. This report covers the work performed by the [redacted] STAT during the period from 22 November to 22 December 1965.

The key to the electrical-chemical processing is control of acutance and granularity in processed transparencies by adjustment of density thresholds, expansion and contraction of densities, and application of modulated-light contact printing. The key to the electronic processing, both analogous and complementary to the electrical-chemical processing, is separate and simultaneous operation on the high and low frequency information in the photographic images.

A. Current Status of Work

1. Electrical-Chemical Processing

STAT The [redacted] copy camera was calibrated for photo-reduction factors of 10:1 and 7:1 with a 12-inch focal length [redacted] lens. STAT The camera was also calibrated for reductions of 7:1 and 4:1 with a STAT 9.5-inch [redacted] lens.

Preliminary testing and calibration of the modulated-light contact printer were begun. The equipment was operated in the unmodulated mode to determine cathode ray tube light uniformity and equivalent density uniformities for several types of film, resolution limits by monoscope-target (10 to approximately 300 cycles/mm) replication, and density properties by step-tablet (21, 36 and 64 step) reproduction.

The printer was also operated in the modulated mode to determine cathode ray tube illumination properties and equivalent density figures for several types of film. These tests revealed equipment faults which must be corrected.

The transparency incorporating simple geometrical shapes and a scene-chip area was prepared. Reproduction of the composite image in states representing known degrees of defocus, over-exposure, and smear or motion (to provide a set of test targets for initial processing experiments) was nearly completed.

2. Electronic Processing

The investigation of light non-uniformity in the bread-board electronic processing system was continued. The dual glass condensers which replaced the Fresnel lens in front of the photo-multiplier produced better uniformity but higher attenuation of the blue light. Thus, a required tradeoff between picture quality and signal-to-noise ratio was indicated.

Electronic edge enhancement (the placing of narrow white borders on black objects or narrow black borders on white objects) using a variable delay line to simulate differentiation was demonstrated to the Technical Representative. The technique holds promise for increasing edge contrast without seriously affecting large-area contrast. Further evaluation awaits the delivery and installation of isotropic-scan equipment.

Attendance at the M.I.T. Industrial Liaison Symposium entitled "Sensing, Analyzing and Processing Visual Information" acquainted project personnel with imaging devices being developed at M.I.T. None of the seven papers presented was directly related to the current study efforts.

B. Problem Areas Encountered

Preliminary testing and calibration of the modulated-light contact printer revealed two faults which must be corrected. Cross-hatching or banding in the cathode ray tube printing raster may be due to electrical noise in the video feedback loop. Also, the light modulation resulting from negative feedback is inadequate for replication purposes; in this case the light-pickup sensitivity may be too low. These two limitations on performance will be investigated further during the next monthly period.

C. Projected Work for Next Monthly Period

1. Electrical-Chemical Processing

a. Complete preparation of test targets for initial processing experiments.

b. Modify modulated-light contact printer as required.

c. Continue testing and calibration of modulated-light contact printer.

d. Begin processing experiments with degraded test targets (a).

2. Electronic Processing

a. Continue processing experiments with preliminary breadboard electronic image-processing system.

b. Anticipate delivery of the special Celco deflection yoke driver and the high-resolution [redacted] cathode ray tubes. STAT

c. Upon receipt of the driver and tubes (b), begin construction of the final breadboard system.

In addition to the above, an analysis of the techniques--centered about the modulated-light printing sources--will be started during the next period.

D. Status of Fund Expenditures to End of Monthly Period

Funds expended (and committed) at break-even level to 31 December 1965:

STAT

E. Documentation of Verbal Commitments and/or Agreements During the Period

STAT Under this task order, [ ] must investigate the feasibility of applying modulated-light techniques to rear projection viewing. At their meeting with the Technical Representative on 13 December, project personnel agreed to prepare an informal proposal for a 3-month sub-study in this area. This proposal should be forwarded to and evaluated by the Technical Representative as soon as possible.